GSFC S-311-P-8(17)
February 1973

GSFC SPECIFICATION

CRYSTAL UNITS, QUARTZ, FOR SPACE FLIGHT USE

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Parts Branch

GODDARD SPACE FLIGHT CENTER
Greenbelt, Maryland

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GODDARD SPACE FLIGHT CENTER

GREENBELT, MARYLAND

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TABLES

1. SCOPE

1.1 PURPOSE. This specification and associated detail specifications cover the requirements for high- and low-frequency quartz crystal units for which special additional requirements are imposed to assure reliable performance in space environments and critical ground-support applications.

1.2 MISSION GOAL. These crystal units must meet the rigors of launch and subsequent extended space flight with extremely high probability of successful operation.

1.3 TYPE DESIGNATION. Type designation applies to crystal units procured in complete compliance with this specification.

P8(17) - X - XX - XXXRX

- XXXRX: Decimal (R indicates position of decimal)
- XXX: Resonant Frequency (MHz)
- XX: Holder - (Figure number followed by p for pin and 1 for lead, 3.2.2.3)
- X: Detail Specification
- P8(17): GSFC Part Category Designator

2. APPLICABLE DOCUMENTS

The following documents, of the issue in effect on the date of invitation for bids, form a part of this specification to the extent specified herein.

2.1 SPECIFICATIONS

Military

MIL-H-10056 . . . . . Holders, Crystal, General Specifications for

2.2 STANDARDS

MIL-STD-129 . . . . . Marking for Shipment and Storage

MIL-STD-202 . . . . . Test Methods for Electronic and Electrical Component Parts

2.3 OTHER PUBLICATIONS

NASA

NHB 5300.4(1C) . . . . . Inspection System Provisions for Aeronautical and Space System Materials, Parts, Components and Services.

2.4 COPIES OF THE DOCUMENTS. Copies of military documents should be obtained from the Navy Supply Depot, Philadelphia, Pennsylvania 19120. Application for copies of NASA documents should be addressed to the Superintendent of Documents, Government Printing Office, Washington, D. C. 20025.

2.5 ORDER OF PRECEDENCE. For purposes of interpretation in case of conflicts, the following order of document precedence shall apply:

(a) Purchase order or contract: The purchase order or contract shall have precedence over any referenced document.

(b) General specification: This specification shall have precedence over all documents listed in 2.1, 2.2, and 2.3. In the event of conflict between the requirements of this specification and the detail specification, the latter shall govern.

3. REQUIREMENTS

3.1 QUALIFICATION. The quartz crystal units furnished under this specification shall be products that have been tested and have passed the quality assurance provisions of Section 4. Manufacturers approved to supply crystal units in accordance with this specification shall not make changes of any kind in the design, material, finish, part number, or any detail of construction without first obtaining written agreement to the changes from the GSFC Parts Branch. The manufacturer shall not fabricate these crystal units at any facility or location different from that which has been used for the fabrication of the approved qualification samples, and which has been approved to NHB 5300.4(1C). Failure to observe these restrictions may be considered sufficient reason to withdraw approval from that manufacturer.

3.2 MATERIAL, DESIGN, AND CONSTRUCTION

3.2.1 Material. The material shall be as specified herein. However, if a definite material is not specified, a material shall be used which will enable the crystal units to meet the performance requirements of this specification. No cadmium plating shall be used on crystal holders. No solder-sealed holders shall be used. Acceptance or approval of any constituent material shall not be construed as a guarantee of the acceptance of the finished product.

3.2.2 Design and construction. Crystal units shall be of the design, construction, and physical dimensions specified in the applicable detail specification and the Appendix of this specification.

3.2.2.1 Welding. Welding, when used in the fabrication of crystals (exclusive of the sealing process), shall conform to the following requirements: All welding performed in the construction of the crystal shall have a tensile strength equal to or greater than 50 percent of the strength of the weaker element of the two elements being welded. Demonstration of the minimum weld strength shall be made on identical materials used in the construction of the crystal.

3.2.2.2 Bonding. Termination of the support structure to the crystal element shall be made by means other than pressure contact. The bonding shall withstand a force of 200 grams perpendicular to the crystal face when tested to 4.6.1.3.

3.2.2.3 Crystal holder. All crystal holders shall be hermetically sealed glass or coldweld metal enclosures, in accordance with figures shown in the Appendix. No cadmium-plating or solder-sealing shall be employed. For GSFC-type designation, use the figure number to identify the holder. Glass cases shall be free of strains or cracks.

3.2.2.4 Mode of operation. The crystal shall use the series-resonant characteristic and shall operate on the mode of oscillation stated in the detail specification.

3.2.2.5 Rated drive level. The rated drive level shall be as specified in the detail specification.

3.2.2.6 Operating temperature range. The crystal unit shall operate within the specified frequency tolerance over the temperature range as specified in the detail specification.

3.2.2.7 Markings. The crystal holder shall be permanently and legibly marked with the following information:

(a) GSFC part number

(b) Date of manufacture

(c) Manufacturer's name or trademark

(d) Serial number

3.2.2.8 Workmanship. Crystal units shall be processed in such a manner as to be uniform in quality and free from any defects that will affect life, serviceability, or appearance. The interiors of crystal units shall be free from flux and flux residues, loose solder, foreign or unapproved materials, dust, or loose particles of any sort. Burrs and sharp edges shall be removed. Glass envelopes shall be stress-relieved.

3.3 PERFORMANCE REQUIREMENTS. The crystal units shall conform to the following electrical and performance characteristics at an ambient temperature of 298 ± 2K, unless otherwise specified.

3.3.1 Resonant frequency. When tested in accordance with 4.6.2, the resonant frequency of the crystal unit shall be as specified in the detail specification.

3.3.2 Resonance resistance. The resonance resistance at the series-resonant frequency shall have a maximum value as specified in the detail specification.

3.3.3 Shunt capacitance. The shunt capacitance, measured as specified in 4.6.3, shall have a maximum value as specified in the detail specification.

3.3.4 Reduced drive level. (Applicable only to crystal units designed for overtone operation.) Crystal units shall operate, but not necessarily within specified frequency limits, when tested as specified in 4.6.4.

3.3.5 Unwanted modes. Unwanted modes of oscillation within 20 percent of the nominal specified frequency shall have resistance greater than 1.5 times the main mode resistance or as specified in the detail specification when tested as specified in 4.6.5.

3.3.6 Temperature stability. The resonant frequency of the crystal unit shall remain within the specified tolerance of the nominal specified frequency over the temperature range as specified in the detail specification when tested to 4.6.6.

3.3.7 Temperature cycle. The crystal unit shall be subjected to a temperature-cycle test as specified in 4.6.7.1. The frequency shift caused by temperature cycling shall not exceed the specified limit of the detail specification. Resonant resistance shall not change more than ±10 percent.

3.3.8 Insulation resistance. The insulation resistance of the crystal unit shall not be less than 500 megohms. Points of measurement shall be as specified in 4.6.8.

3.3.9 Vibration. The crystal unit shall be subjected to vibration tests as specified in 4.6.9. The allowable frequency shift caused by vibration exposure shall not exceed 0.0005 percent. Resonant resistance shall not change more than 10 percent.

3.3.10 Shock. The crystal unit shall be subjected to a shock test as specified in 4.6.10. The frequency shift caused by shock exposure shall not exceed 0.005 percent. The resonant resistance shall not change more than ±10 percent.

3.3.11 Seal. The crystal-unit seal shall have a maximum leak rate of 10^{-8} atm cc/sec when measured as specified in 4.6.11.

3.3.12 Aging. The crystal unit shall be exposed to the aging test specified in 4.6.12. The change of resonant frequency over 1 year, as extrapolated from the final 30 days of aging as a minimum, shall not change more than the specified limit of the detail specification. Resonance resistance shall not change more than ±10 percent from aging during the test.

3.3.13 Terminal strength. The crystal unit shall be subjected to terminal-strength tests as specified in 4.6.13. Terminals shall not break. Glass seals shall not exhibit cracking or chipping when examined under 10X magnification.

4. QUALITY ASSURANCE PROVISIONS

4.1 CLASSIFICATION OF TESTS; Testing of the crystals shall be classified as follows:

(a) Qualification tests (4.4)

(b) Acceptance tests (4.5)

4.2 INSPECTION RESPONSIBILITY. Unless otherwise specified in the purchase order, the supplier is responsible for the performance of all inspection requirements specified herein. GSFC reserves the right to repeat any of these inspections and to reject any submitted units or lots that fail to meet prescribed requirements.

4.2.1 Test conditions. Unless otherwise specified, all measurements and tests shall be made at 298K ± 2K, room-ambient atmospheric pressure, and ambient humidity.

4.2.2 Submission of test data. Two copies of all acceptance-test data and certifications applicable to the crystals being shipped, and as required by this specification, shall accompany each shipment of crystals on GSFC procurements. One of these copies shall be forwarded to the GSFC Parts Branch.

4.3 TEST EQUIPMENT AND INSPECTION FACILITIES. Test equipment shall be of sufficient accuracy and quality to permit performance of the required inspection tests. The manufacturer shall establish adequate calibration of test equipment to the satisfaction of GSFC. The manufacturer shall allow a GSFC representative access within reason to the manufacturing and test facility to verify whether the crystals are being supplied in accordance with this specification.

4.4 QUALIFICATION TESTS

4.4.1 Sample. A sample of 6 crystal units, one uncased unit, and a sample of any welds used in fabrication (except for can seals) shall be submitted to qualification tests. When more than one frequency tolerance is specified, the closest tolerance will be selected for the sample. The samples submitted shall be made in accordance with the established manufacturing processes as specified herein (3.1). The sample shall come from a screened

lot (group A acceptance tests). Sample crystals shall be subjected to the qualification tests listed in Table I in the order shown.

4.4.2 Defectives. A detailed failure analysis shall be performed on failing crystals or on representative failed specimens having a similar failure mode under the same test conditions. The failure analysis shall be designed to isolate the cause or causes of failure, to yield adequate conclusions to initiate a plan for corrective action to eliminate the cause, and to prevent recurrence of the type of failure mode reported. Defective crystal units in excess of those allowed in Table I will be cause for refusal to grant qualification.

4.4.3 Disposition of samples. Test samples shall be identified as qualification test samples and shipped to the Applications Section, GSFC Parts Branch, upon completion of qualification tests.

4.5 ACCEPTANCE TESTS

4.5.1 Inspection of crystal units for delivery. Inspection of crystal units for delivery shall consist of group A tests. An inspection lot shall consist of all crystal units of the same specified frequency having the same GSFC part number which are submitted at one time to acceptance tests for delivery.

4.5.2 Group A tests. Group A tests shall consist of the tests specified in Table II, and shall be performed on 100 percent of the crystal units shipped against an order. Only those crystal units which pass group A tests may be shipped.

4.5.2.1 Lot rejection. If the number of crystals failing to pass vibration, seal and aging tests of group A exceeds 10 percent of the lot or one unit, whichever is greater, the purchaser shall be notified and the entire lot shall be subject to rejection. Rejected lots may be resubmitted if the cause for failure has been determined and the corrective action taken has met the approval of the purchaser. If 1 percent of the lot or one unit, whichever is greater, fails during reinspection, the purchaser shall again be notified and the appropriate lot disposition will be made.

Table I. Qualification Tests

	Requirement Paragraph	Method Paragraph	Number of Specimens to be Inspected	Number of Defectives Allowed
Group I				
Visual and mechanical inspection (internal), materials, design, and workmanship	3.2.1	4.6.1	1 uncased	0
Bond strength	3.2.2.2	4.6.1.2		
Group II				
Visual and mechanical inspection (external), dimensions, marking, and workmanship	3.2.2	4.6.1.3	6	1
Resonant frequency	3.3.1	4.6.2		
Resonance resistance	3.3.2	4.6.2		
Shunt capacitance	3.3.3	4.6.3		
Reduced drive level	3.3.4	4.6.4		
Unwanted modes	3.3.5	4.6.5		
Temperature stability	3.3.6	4.6.6		
Temperature cycle	3.3.7	4.6.7.1		
Insulation resistance	3.3.8	4.6.8		
Vibration	3.3.9	4.6.9		
Shock	3.3.10	4.6.10		
Seal	3.3.11	4.6.11		
Aging (operating)	3.3.12	4.6.12		
Terminal strength	3.3.13	4.6.13		

4.5.2.2 Failure analysis. A detailed failure analysis shall be performed on failing crystals or on representative crystals having a similar failure mode. The failure analysis shall be designed to isolate the cause or causes of failure, to yield conclusions adequate to initiate a plan for corrective action to eliminate the cause, and to prevent recurrence of the type of failure mode reported.

Table II. Group A Tests (100 percent)

Examination or Test	Requirement Paragraph	Method Paragraph
Temperature stability	3.3.6	4.6.6
Temperature cycle	3.3.7	4.6.7.2
Insulation resistance	3.3.8	4.6.8
Resonant frequency	3.3.1	4.6.2
Resonance resistance	3.3.2	4.6.2
Shunt capacitance	3.3.3	4.6.3
Reduced drive level	3.3.4	4.6.4
Unwanted modes	3.3.5	4.6.5
Vibration	3.3.9	4.6.9.3
Seal	3.3.11	4.6.11
Aging (30 days)	3.3.12	4.6.12.2
External visual inspection	3.2.1	4.6.1.3

4.6 TEST METHODS

4.6.1 Visual and mechanical

4.6.1.1 Internal. The interior of the uncased crystal shall be examined. to verify that the internal design, construction, and workmanship are in accordance with applicable requirements, 3.2.1 and 3.2.2.

4.6.1.2 Bond Strength. A force shall be gradually applied to each supporting wire at a right angle to the crystal face until the specified bond-strength value of 200 grams is reached. The full force shall be applied for not more than 1 minute. Breaking of the vibrator during this test shall not be construed as a bond-strength failure; however, the crystal unit shall not be considered to have satisfactorily passed this test, and another unit shall be tested (3.2.2.3).

4.6.1.3 External. Crystal units shall be examined to verify that the external design, construction, physical dimensions, marking, and workmanship are in accordance with the applicable requirements. Glass-encased units shall be examined under 10X magnification for flaws in the case and seals.

4.6.2 Frequency and resistance. The crystal unit shall be inserted into the applicable test set and the frequency (f_o) and equivalent

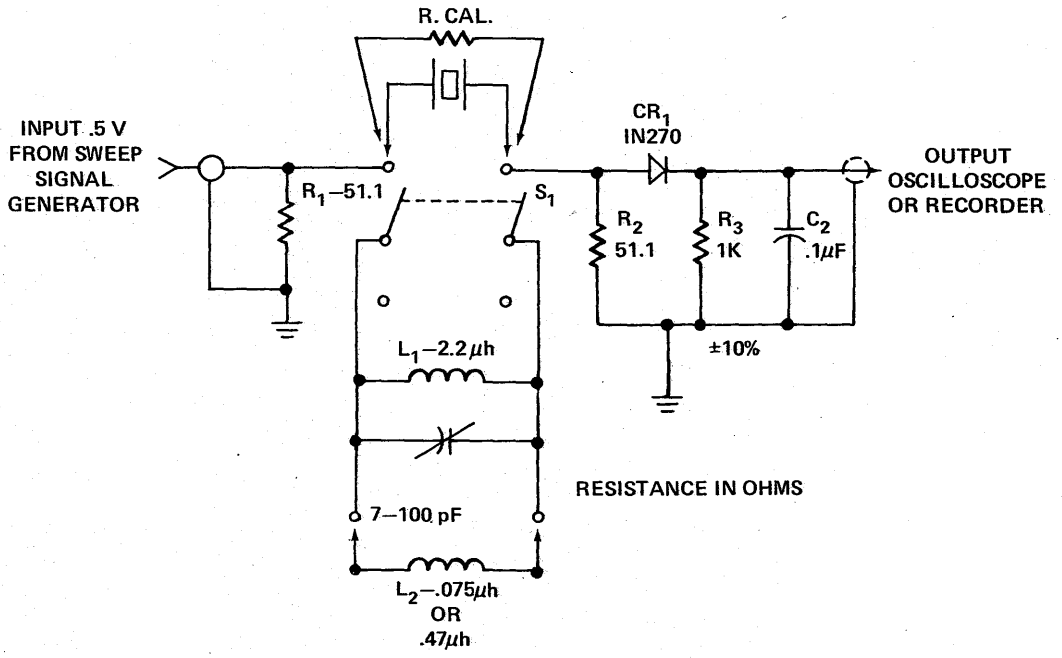
resistance (R_o) shall be measured with the unit in thermal equilibrium at room temperature (or at the reference temperature when crystal units are designed for operation under controlled temperature conditions).

4.6.3 Shunt capacitance. Crystal units shall be tested in accordance with method 305 of Standard MIL-STD-202. The capacitance shall be measured from pin to pin, with the crystal holder ungrounded, at a frequency which is lower than the fundamental frequency of the unit and at which the unit shows no oscillation response.

4.6.4 Reduced drive level. (Applicable only to crystal units designed for overtone operation). Crystal units shall be tested for operation at 25 percent of the rated drive level.

4.6.5 Unwanted modes. Crystal units shall be tested using the test circuit in figure 1. The test shall be performed at room ambient temperature for all crystal units. A frequency range of approximately 200 kHz above and 200 kHz below the specified frequency shall be swept by the signal generator. S_1 shall be set in the open position for crystal units with operating frequencies below 12 MHz. For crystal units with operating frequencies above 12 MHz, S_1 shall be set in the closed position, the proper inductance value for L_2 shall be used, and C_1 shall be adjusted to parallel resonate the static capacitance (C_o), as evidenced by an indication of zero or minimum amplitude on the oscilloscope or recorder. The output oscilloscope or recorder shall be observed for unwanted modes whose resistance does not exceed one and a half times the main mode resistance or the maximum specified resistance, whichever is greater.

4.6.6 Temperature stability. The temperature of the crystal unit shall be varied so as to traverse the entire operating range from low temperature to high temperature. For the operating temperature range of 218K to 378K, the temperature range shall be traversed in eight ±1 minutes, unless otherwise specified (see 3.1). For other operating temperature ranges, the time shall be proportional. Measurements of frequency and equivalent resistance shall be recorded continuously or at intervals of not over 3K to ascertain that tolerances are not exceeded at any instant. The temperature of the end points shall be accurate to within ±1K of specified temperatures.



NOTE: R1 AND R2 SHALL BE A 1 PERCENT FILM RESISTOR

Figure 1. Unwanted Modes Test Circuit

The end-point frequencies shall be within ±5% of the specified overall frequency tolerance when compared to the equilibrium frequency at these end-point temperatures. For example, if the specified frequency tolerance is ±0.005% (overall 100 ppm) then the end-point tolerance is 5 ppm. The temperature run shall be performed automatically from the low temperature to the high temperature using T/C analyzer, Winslow Tele-Tronics, Inc., Model TCA-1070, or equal. No manual adjustments shall be made to the test setup once the temperature run has begun." NOTE: This type of temperature run may cause some distortion of the frequency temperature characteristics.

4.6.7 Temperature cycle

4.6.7.1 Qualification. Crystal units shall be placed in a test chamber equipped with timing controls that produce the cycle specified in Table III. The test shall continue for 100 continuous cycles,

Table III. Temperature Cycle

Step	Temperature (K)	Time (min)
1	218 +0 -3	30
2	298 +10 -5	10, max
3	373 +3 -0	30
4	298 +10 -5	10, max

or with as few interruptions as possible which shall be recorded with the test data. Frequency and resistance shall be measured before and after the temperature cycle exposure.

4.6.7.2 Group A tests. Crystal units shall be tested as specified in 4.6.7.1. The test shall continue for 10 cycles without interruption.

4.6.8 Insulation resistance. Crystal units shall be tested in accordance with method 302 of MIL-STD-202. The following details shall apply:

(a) Test potential: 100vdc

(b) Points of measurement: For units with metal holders, measurements shall be made between each pin and the holder.

4.6.9 Vibration

4.6.9.1 Sinusoidal. Crystal units shall be tested in accordance with method 204 of MIL-STD-202, test condition D except to 30G maximum, unless otherwise specified. The frequency and resonant resistance shall be measured before and after the vibration exposure.

4.6.9.2 Random. The crystal units shall be tested in accordance with method 214 of MIL-STD-202, test conditions I and F, for 15 minutes. The frequency and resonance resistance shall be measured before and after the vibration exposure.

4.6.9.3 Group A vibration test. The group A acceptance-vibration test shall be limited to one sweep from 20 to 2000 Hz. Each crystal unit shall be securely mounted so that the primary vibration axis is perpendicular to the flat side of the crystal element. Crystal frequency f_o shall be monitored for one vibration sweep according to method 204 of MIL-STD-202, test condition C.

4.6.10 Shock. Crystal units shall be tested in accordance with method 213 of MIL-STD-202, test condition A. The frequency and resonant resistance shall be measured before and after each blow. The crystal shall be subjected to one blow in each of three mutually perpendicular axes.

4.6.11 Seal. Crystal units shall be tested in accordance with method 112 of MIL-STD-202B, test condition C, procedure IIIb.

4.6.12 Aging

4.6.12.1 Operating. Crystal units shall be maintained at the aging temperature of 358K ±2K and operated with rated drive level at the normal specified frequency for a continuous period of 30 days. The frequency shall be measured at the end of the first 24 hours and then twice a week at intervals of not less than 2 days nor more than 4 days for the duration of the test. All frequency measurements shall be made with the crystal unit in the 358K test chamber, the temperature at the time of measurement being within ±1K of the initial temperature measurement (4.6.12.3).

4.6.12.2 Nonoperating. Crystal units shall be conditioned (nonoperating) at a temperature of 358K ± 2K for a 30-day period. While the units are in the storage chamber, frequency shall be measured at the end of the first 24 hours and of the first 30 days. At measurement times, temperatures shall not differ by more than ±1K (4.6.12.3).

4.6.12.3 Measurement precautions. The accuracy of resetting the frequency of the test set shall be 5×10^{-5} percent. The same test set shall be used throughout the test. Crystal units should

remain in the test chamber within specified limits of the test. If the temperature drops below the aging temperature for any time interval of more than 1 hour, no measurement shall be made until 24 hours after temperature restoration, and the 30-day test period shall be lengthened to cover the time interval.

4.6.13 Terminal strength

4.6.13.1 Wire-lead-terminal crystal units. Crystal units shall be firmly mounted, and a 0.9 Kg load (2 pound) shall be applied to each terminal, one at a time, in a direction along the lead axis of the crystal unit. After the load has been removed, two leads on each crystal unit shall be bend tested. A weight of 0.23 Kg (8 ± 0.5 ounces) shall be applied to each lead, one at a time, and the case rotated through 90 ± 5 degrees. This shall be repeated for three arcs, with each arc defined as a 90 ± 5 degrees and back to normal. All arcs shall be in the same direction and in the same plane without lead restriction. One arc shall be completed in from 2 to 5 seconds.

4.6.13.2 Pin-terminal crystal units. Crystal units shall be firmly mounted and a pull of 4.54 Kg (10 pounds ± 10 ounces) shall be applied to each pin, one at a time, in a direction along the pin axis of the crystal unit. Upon completion of the pull test, a torque test shall be applied to each terminal. The body of the crystal unit shall be securely clamped with a suitable fixture, and a torque of 5 ± 0.5 in-oz shall be applied to the portion of the terminal nearest the seal for a minimum time of 10 seconds. The specified torque shall be applied, without shock, about the device axis. The torque shall be applied between the lead or terminal and the case, in a direction which tends to loosen the lead or terminal. Frequency and resonance resistance shall be measured as specified in 4.6.2, before and after the terminal-strength test.

5. PREPARATION FOR DELIVERY

5.1 PRESERVATION AND PACKAGING. Crystal units shall be individually packaged and shall be afforded preservation and packaging in accordance with the supplier's normal commercial practice.

5.2 PACKING. Crystal units, packaged as specified, shall be packed in containers of the type, size, and kind commonly used for the purpose, and in

a manner that will ensure acceptance by a common carrier and a safe delivery at destination. Shipping containers shall comply with the uniform freight classification rules or regulations of other carriers as applicable to the mode of transportation. Insofar as possible and practical, exterior containers shall be uniform in shape and size, and of minimum cube and tare consistent with the protection required.

5.3 MARKING. In addition to any special marking required by the contract or order, unit packages, intermediate packages, and exterior shipping containers shall be marked in accordance with MIL-STD-129.

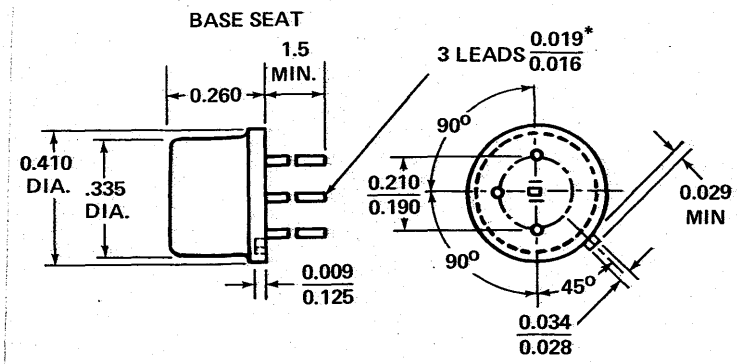
6 NOTES

Not applicable.

APPENDIX

CRYSTAL HOLDERS

Holders shall be hermetically sealed glass or nonmagnetic Coldweld metal containers in accordance with the following Figures, 1 through 7. Pins are not recommended for flight-equipment use unless connection is assured by soldering to the pins. All dimensions are maximum and in inches (and millimeters in tables) unless otherwise indicated.

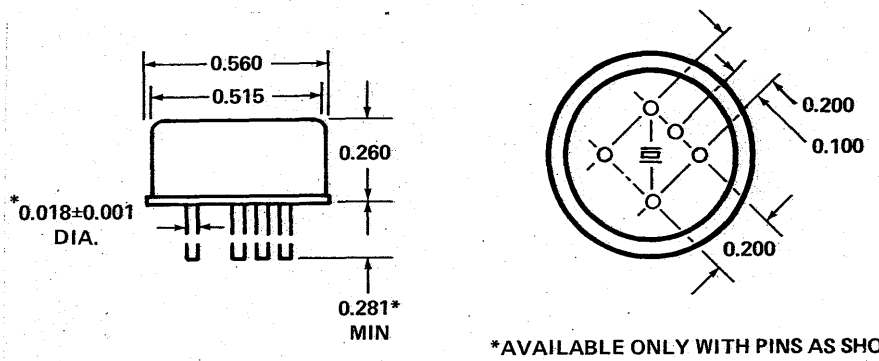


INCH	MM
.009	.229
.016	.406
.028	.711
.029	.737
.034	.863
.125	3.17

INCH	MM
.190	4.83
.210	5.33
.260	6.60
.335	8.51
.410	10.41
1.500	38.10

*AVAILABLE ONLY WITH LEADS AS SHOWN

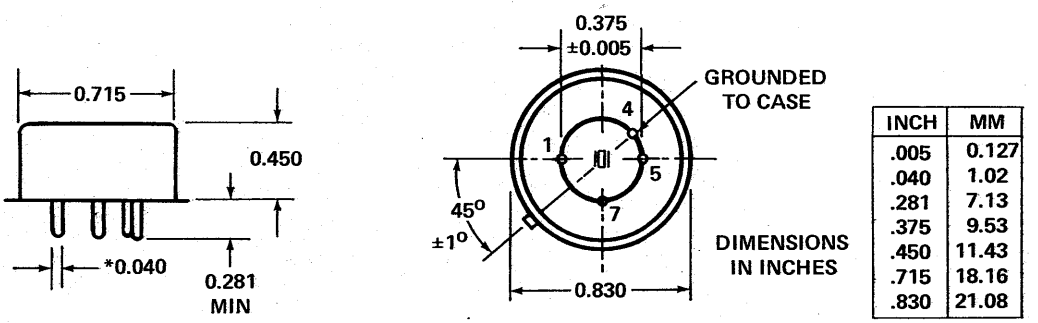
Figure 1(L). TO-5 Coldweld Enclosure



INCH	MM
.001	.025
.018	.457
.100	2.54
.200	5.08
.260	6.60
.281	7.14
.515	13.08
.560	14.22

*AVAILABLE ONLY WITH PINS AS SHOWN

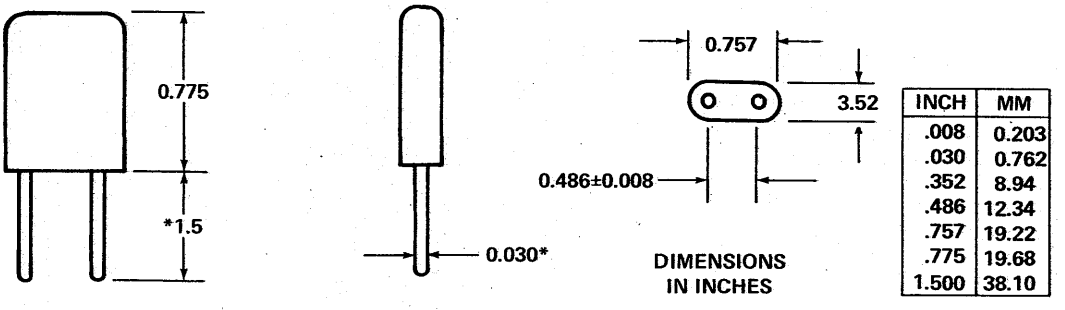
Figure 2(P). TO-8 Coldweld Enclosure



INCH	MM
.005	0.127
.040	1.02
.281	7.13
.375	9.53
.450	11.43
.715	18.16
.830	21.08

*AVAILABLE ONLY WITH PINS AS SHOWN

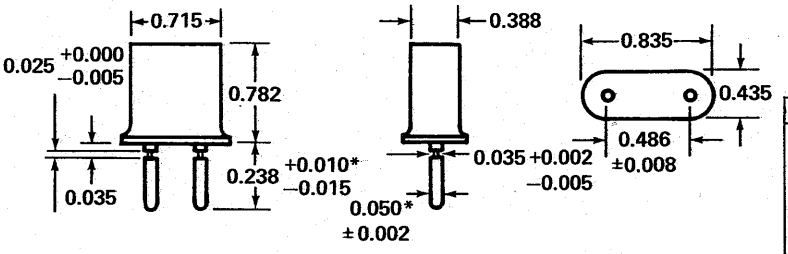
Figure 3(P). Coldweld Enclosure



INCH	MM
.008	0.203
.030	0.762
.352	8.94
.486	12.34
.757	19.22
.775	19.68
1.500	38.10

*AVAILABLE WITH LEADS (FIGURE 4(L) OR PINS (FIGURE 3(P)). PINS OR WIRES SHALL BE KOVAR PER MIL-STD-1276, TYPE K, COATING PER MIL-T-10727, TYPE II (HOT-TIN-DIPPED). THE CRYSTAL HOLDER IS PER MIL-H-10056.

Figure 4(L). HC 27/U Glass Enclosure



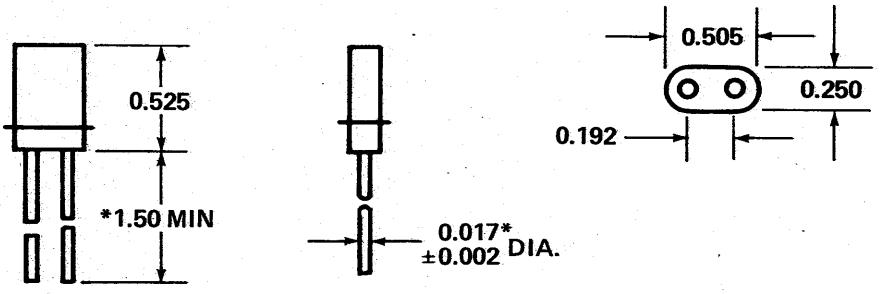
INCH	MM
.002	.051
.005	.127
.010	.254
.015	.381
.025	.635
.035	.889
.050	1.270

INCH	MM
.238	6.04
.388	9.86
.435	11.05
.486	12.34
.715	18.16
.782	20.86
.835	21.21

*DIMENSIONS IN INCHES

*AVAILABLE WITH PINS (FIGURE 5(P)) OR LEADS (FIGURE 7(L)). THE CRYSTAL HOLDER IS PER MIL-H-10056.

Figure 5(P). HC-6 Coldweld Enclosure

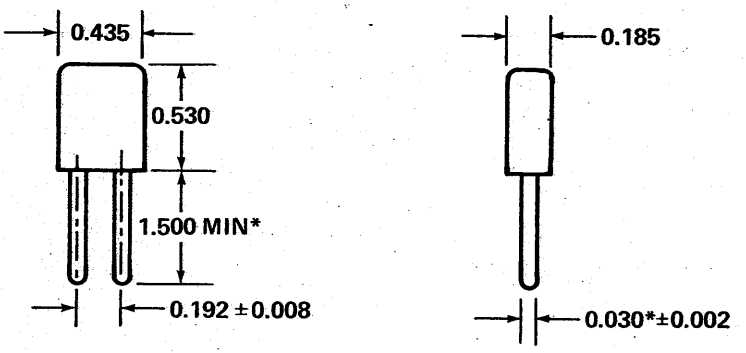


INCH	MM
.002	.051
.017	.432
.192	4.88
.250	6.35
.505	12.83
.525	13.34
1.500	38.10

DIMENSIONS IN INCHES

*AVAILABLE WITH LEADS AS SHOWN. THE CRYSTAL HOLDER IS SIMILAR TO THE HC-18 GLASS ENCLOSURE.

Figure 6(L). HC-18 Glass Enclosure



INCH	MM
.002	.051
.008	.203
.030	.762
.185	4.70
.192	4.88
.435	11.05
.530	13.46
1.500	38.10

DIMENSIONS IN INCHES

*AVAILABLE WITH LEADS (FIGURE 6(L)), OR WITH PINS (FIGURE 5(P)). THE CRYSTAL HOLDER IS SIMILAR TO HC-18 COLDWELL ENCLOSURE.

Figure 7(L). HC-18 Coldweld Enclosure